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Performance Analysis Of Routing Behaviour Between OSPF And EIGRP In Hierarchical And Flat Structures

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Abstract:
Networking has evolved immensely in recent years. With the growing need to distribute applications across multiple networks and the availability of high capacity, high-performance intermediate switching nodes and networks, an efficient routing mechanism has become the core requirement. Standards based protocols have become a requirement for today's networks. Currently deployed dynamic routing protocols that are used to propagate network topology information to the neighboring routers are Enhanced Interior Gateway Routing Protocol (EIGRP), and the Open Shortest Path First (OSPF) protocol. The choice of the right routing protocol depends on a number of parameters. The simulator software GNS3(Graphic Network Simulator version 3) shows the impact of routing protocol in hierarchical and flat structure for different types of applications. In this research work, it will analyze the routing behavior of OSPF and EIGRP with regard to their structure that is hierarchical and flat and also consider the parameters such as bandwidth and delay. Another Network Simulator OPNET is also used for comparing the different parameters of OSPF and EIGRP Protocols. At present, most routing design typically routes all the traffic over one exposed single path, which are innately slow in responding to congestion and traffic burst. Furthermore, the use of only one single path often originates the wastage of network resources. As a single-path routing protocol, Open Shortest Path First (OSPF) suffers the same problems. An alternative method is developed to solve the problems in single path by using many different paths. So, the new routing protocol using programming language C++ is proposed which can control the congestion, perform better load balancing, achieve better network utilization and lesser delay during transmission of data.

Keywords: Routing, OSPF, EIGRP, Structure, Multipath Routing, Traffic Type.

1. Introduction
Routing is the process of moving information across an internetwork from a source to a destination. Along the way, at least one intermediate node typically comes across. Routing is often compared with bridging, which might seem to carry out precisely the same thing to the casual observer. The primary difference between the two is that bridging occurs at Layer 2 (the data link layer) of the OSI reference model, whereas routing occurs at Layer 3 (the network layer). This feature provides routing and bridging with different information to use in the process of moving information from source to destination, so the two functions carry out their tasks in different ways. The matter of routing has been covered in computer science literature for more than two decades, but routing attains commercial popularity as late as the mid-1980s. The primary cause for this time lag is that networks in the 1970s were simple, homogeneous environments. But now a days large-scale internetworking become popular.

1.1 Dynamic Routing Protocols Overview
Dynamic routing protocols are used by routers to perform determine routes. Routers then mechanically promote packets (or datagrams) over those routes. Statically programmed routers cannot find out routes; they lack in any mechanism to communicate routing information with additional routers. Statically programmed routers can only promote packets using routes defined by a network administrator.

1.2 OSPF (Open Shortest Path First)
OSPF was designed specifically as an IP routing protocol for utilize within autonomous systems. As such, it cannot transport datagrams of additional routable network protocols such as IPX or AppleTalk. OSPF computes routes based on the destination IP address found in IP datagram headers; and no provisions are made for calculating routes to non-IP destinations. Additionally, the different OSPF messages are encapsulated directly in IP: No other protocols (TCP, UDP, and so on) are needed for delivery. OSPF was also designed to quickly discover topological changes in the autonomous system and converge on a new consent of the topology after detecting a change. Routing decisions are depend on the state of the links interconnecting the routers in the autonomous system. Each of these routers maintains an similar database that tracks link states in the network. Included in this database is the state of the router. This includes its functional interfaces, known-reachable neighbors, and link-state information. Routing table updates, known as Link-State Advertisements (LSAs), are transmitted directly to all further neighbors within a router's area. The technical term for this revision process is flooding, a rather unflattering term with a negative suggestion that belies the actual performance characteristics of OSPF. In practice, OSPF networks converge very speedily. All routers within the network run the similar routing algorithm and transmit routing table updates directly

to each other. This information is used to build an image of the network and its links. Each router's picture of the network uses a UNIX-like tree structure, with itself as the root. This tree, known as the shortest-path tree, follows the shortest path to each destination within the autonomous system. Destinations outside the autonomous system may be acquired via AS border routers to those external networks and appear as leaves on the shortest-path tree structure. Link-state data cannot be preserved on such destinations and/or networks just because they are outside the OSPF network. Therefore, they cannot come out as branches in the shortest-path tree. One of the reasons OSPF is so scalable is its routing revision mechanism. OSPF uses an LSA to distribute routing information among OSPF nodes. These advertisements are propagated totally throughout an area, but not beyond an area. Therefore, each router within a specified area knows the topology of their area. However, the topology of any given area is not known outside of that area. Given that there are actually four different types of OSPF routers---internal area router, area border router, ASBR, and backbone router---it is clear that each router type has a different set of peers with which LSAs must be exchanged.

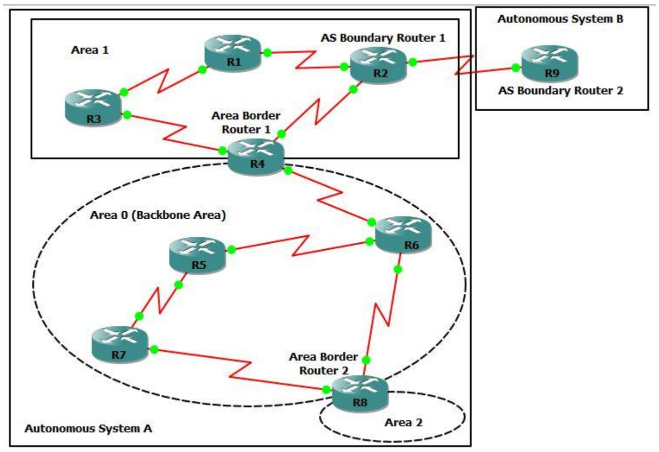

Figure 1: Basic OSPF Network Topology

1.3 OSPF Routing Hierarchy

The OSPF routing hierarchy includes the following entities:

- Autonomous systems
- Areas, including the backbone and normal areas
- Area Border Router (ABR)
- AS Boundary Router (ASBR)

1.4 EIGRP (Enhanced Interior Gateway Routing Protocol)

EIGRP is a cisco's proprietary protocol. EIGRP is a relatively new advancement from Cisco that is based on IGRP. EIGRP shares its predecessor's distance-vector technology, but varies greatly in its operational mechanics. Additionally, EIGRP features contain several important new features. EIGRP is sometimes referred to as a hybrid routing protocol (or an advanced distance vector protocol). It joins the best features of link-state routing with the best features of distance vector routing. Properly designed and implemented, an EIGRP network is really stable and efficient and converges quickly after any topological change. Enhanced Interior Gateway Routing Protocol (EIGRP) is a distinctive Cisco innovation. Highly valued for its easiness of deployment and fast convergence, EIGRP is commonly used in many huge Enterprise networks. EIGRP maintains all of the advantages of distance vector routing protocols, while avoiding the parallel disadvantages. EIGRP scales effectively in a well designed network and provides extremely fast convergence times with minimal network traffic.

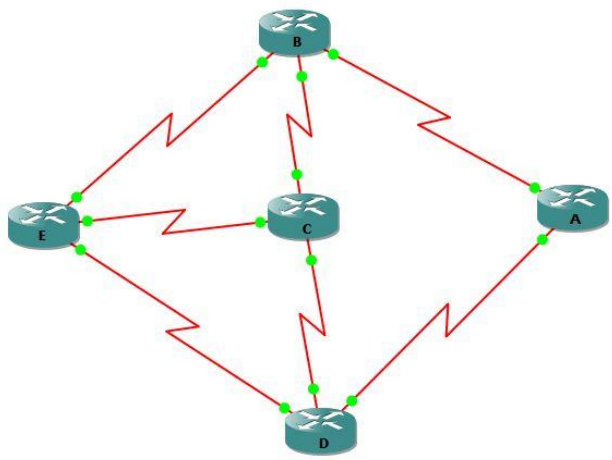

Figure 2: Basic EIGRP Network Topology

1.5 EIGRP Flat Structure

In figure 2, there are five routers A, B, C, D and E, but in this case there not any specific areas that is routers are not divided in the areas like backbone area or stub area as in OSPF.

2. Literature Review

Din, et. al. (2010) studied the behaviour of routing protocols in the real time scenario. The size of today's networks has been growing speedily and support complicated applications, e.g., video conferencing and voice messages. Quality transmission is requirement of the time. This needs some better result producing routing protocols at the routers. During routing, different routing protocols are used at the routers to route real time data (voice and video) to its destination end. These protocols perform well under different circumstances. This literature tells us about how to assess the performance of RIP, OSPF, IGRP, and EIGRP for the parameters: packets dropping, traffic received, End-to-End delay, and variation in delay (jitter). Simulations have been done in OPNET for assessing these routing protocols against each parameter. The results have been exposed in the graphs which show that IGRP performs the best in packets dropping, traffic received, and End-to-End delay as compared to its other companions (RIP, OSPF, and EIGRP), while in case of jitter, RIP performs well comparatively.

Xu, D. and Trajkovic, L. (2011) analyzed the performance of RIP, EIGRP, and OSPF using OPNET. Routing protocols are key elements of modern communication networks. Currently deployed dynamic routing protocols that are used to propagate network topology information to the neighboring routers are

Routing Information Protocol (RIP), Enhanced Interior Gateway Routing Protocol (EIGRP), and the Open Shortest Path First (OSPF) protocol. The choice of the right routing protocol depends on a number of parameters. OPNET Modeler was used to analyze the performance of RIP, EIGRP, and the OSPF protocols, which are commonly deployed in Internet Protocol (IP) networks. They designed various simulation scenarios to compare their performance. Routing protocols are based on routing algorithms, which rely on various metrics to find the best path to transmit data across networks. Metrics include cost, bandwidth, maximum transmission unit (MTU), packet delay, and hop count. Routing protocols utilize a routing table to store the results of these metrics. In this literature, they demonstrated that OPNET Modeler can be employed by network planners to select the most suitable routing protocol for various networks and to design an optimal routing topology.

Sasthiri B. and Prakash T. (2012) identified the traditional routing schemes that route all traffic along a single path, multipath routing strategies divide the traffic among several paths in order to control congestion. They said that multipath routing can be fundamentally more efficient than the traditional approach of routing on single paths. Yet, in contrast to the single path routing approach, there are most studies in the context of multipath routing focused on heuristic methods. They demonstrate the significant benefit of optimal (or near optimal) solutions. Hence, they investigated multi path routing adopting a thorough (theoretical) approach. They formalized problems that integrate two major requirements of multipath routing. Then they established the intractability of these problems in requisites of computational intricacy.

Lesage, et. al. (2008) proposed the application and the implementation of many path routing and multiple description coding (MDC) extension of OLSR, called MP-OLSR. It was based on the link state algorithm and employs periodic exchange of messages for maintaining the topology information of the networks. In the mean time, it updates the routing table in an on-demand scheme and forwards the packets in multiple paths which have been determined at the source node. If a link failure has been detected, the algorithm recovers the route automatically. Concerning the unsteadiness of the wireless networks, the multiple description coding has been used to improve reliability of the network transmission, and several methods are proposed to allocate the redundancy in different paths. The simulation in NS2 shows that the new protocol should be effectively improving the performance of the networks.

Karim, A. and Khan, M. A. (2011) studied about the comparison of five routing protocols: Routing Information Protocol (RIP), Open Shortest Path First (OSPF), Enhanced Interior Gateway Protocol (EIGRP), Interior Gateway Protocol (IGRP) and Intermediate System to Intermediate Systems (IS-IS) protocol. With the growing need to distribute applications across multiple networks and the availability of high capacity, high-performance intermediate switching nodes and networks, an efficient routing mechanism has become the center requirement. The comparison was made on various parameters including the network traffic, IP processing delay, packet loss ratio, CPU utilization, point-to-point throughput and point-to-point queuing delay. The replication work has been done on well known simulator that is OPNET (IT Guru Academic Edition). The outcome of this literature illustrate that the EIGRP protocol requires more CPU cycles when executing the routing algorithm for selecting the best access path. The OSPF protocol imparts the least IP processing delay on routing devices, but OSPF has more packet loss rate as compared to other routing protocols. RIP is the best protocol in terms of utilizing point-to-point throughput. The IS-IS and the IGRP protocols do not seem to perform better than other routing protocols. The protocols EIGRP, OSPF and IS-IS behave very similar in terms of LAN delay, whereas the IGRP protocol produces the highest LAN delay. Overall, they said that OSPF and EIGRP are the two routing protocols that can be deployed in small to medium sized network, and that can work more efficiently than other routing protocols.

Baccelli, et. al. (2010) identified that efficient OSPF (Open Shortest Path First) operation on multi-hop ad hoc wireless networks has become desirable, as wireless community mesh networks and vehicular networks emerge using OLSR (Optimized Link State Routing), a link state MANET routing protocol similar to OSPF in many aspects. OSPF is already extensively deployed and well known in wired IP networks, and could provide simple, seamless unification of wired and wireless IP networking routing-wise, if extended to operate efficiently on ad hoc networks. The IETF has thus proposed three different MANET extensions to the OSPF protocol, allowing heterogeneous networks encompassing both wired and wireless routers, which might self-organize as multi-hop wireless sub networks, and be mobile. Two of these extensions are based on techniques derived from multi-point relaying (MPR). So, in this paper they compare and analyze these two extensions and proposed a unique, merged approach which out-performs the existing extensions.

3. Problem Formulation

As per the various literatures I reviewed, I came to a conclusion that they all worked on the routing behaviour of various dynamic routing protocols with regard to various parameters such as CPU utilization, point-to-point throughput, delay, bandwidth, packet loss ratio but they did not considered any structure about how the routers are connected with each other in a large network. Within a large network there are various kinds of problems like Congestion, Load Balancing, bandwidth, delay, Proper Network Utilization but huge bandwidth and better management are the requirements for solving these sort of issues. Many techniques have been proposed for solving these issues but due to growing needs, better routing solutions are required for providing fault tolerance and quality assurance.

3.1 Methodology

Our focus will be on developing a better solution to this problem as to solve routing issues by some of the most popular simulators such as OPNET, GNS3 and programming language such as C++.

3.2 Flowchart for methodology / planning of work

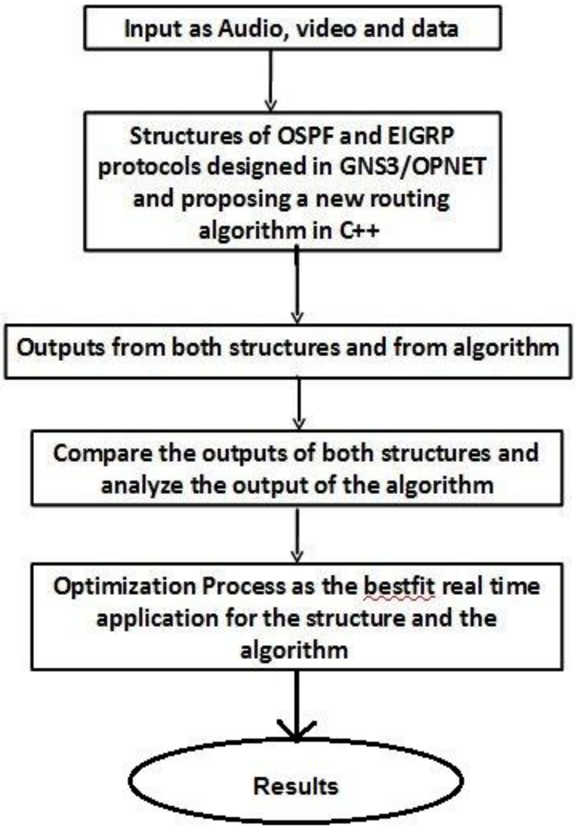

Figure 3: Methodology and Planning of Work

4. Simulation Study and Analysis

This section presents our simulation results to compare performance of the routing protocols.

Experimental Tools:

GNS3: GNS3 is a Graphical Network Simulator that allows emulation of complex networks like real scenarios. GNS3 also supports virtual machine software, due to this GNS3 can also be installed in virtual PC's. GNS3 allows the same type of emulation using Cisco Internetwork Operating Systems. It allows you to run a Cisco IOS in a virtual environment on your computer. GNS3 is a graphical front end to a product called Dynagen. Dynamips is the core program that allows IOS emulation. Dynagen runs on top of Dynamips to create a more user friendly, text-based environment.

OPNET: Network designers are constantly challenged by the growing complexity of communication protocols and the increasing scale of network deployments. Network R&D is no longer a process that can be conceded to spread sheets or traditional software. OPNET modeler accelerates the R&D process for analyzing and designing communication network, devices, protocols and applications. In order for Network R&D organizations to innovate, they need robust network simulation software to easily and intuitively model the intricate end-to-end behavior of protocols.

Programming Language: C++ is a general purpose programming language. C++ is a intermediate level language which is comprises of both the high level and low level language and their features. It was developed by Bjarne Stroustrup in 1979 at Bell Labs. C++ is also known as C with classes. C++ has many features like object oriented features such as encapsulation, polymorphism, data abstraction, so it is a enhancement over the C language. By the help of this programming language, a new routing algorithm is proposed by taking the consideration of various parameters.

4.1 Lab scenarios using GNS3

Lab scenarios are made in GNS3 as the real scenarios.

4.1.1 Scenario depicting only Area 0

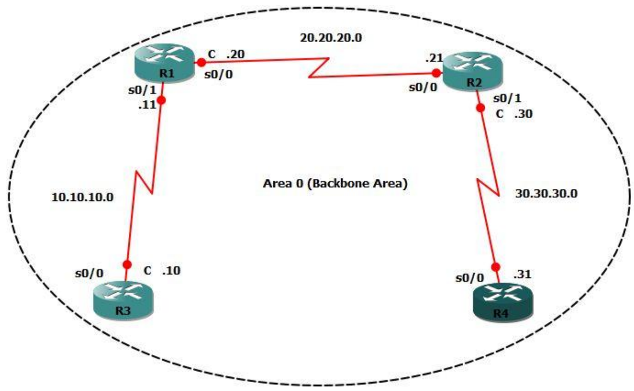

Figure 4: Scenario depicting only Area 0

Overview of Scenario:

In this Scenario, there is only one area that is area 0 or backbone area, in which we consider the number of times the SPF (Shortest Path First) is calculated. The all four routers act as Backbone routers. In the output of this scenario we will see that how many times the SPF is calculated.

Outputs:

Router R3:

R3#show ip ospf
Area BACKBONE(0)
SPF algorithm executed 9 times

Router R1:

R1#show ip ospf
Area BACKBONE(0)
SPF algorithm executed 9 times

Router R2:

R2#show ip ospf
Area BACKBONE(0)
SPF algorithm executed 5 times

Router R4:

R4#show ip ospf
Area BACKBONE(0)
SPF algorithm executed 2 times

Explanation:
In the above results we have observed that router R1 had executed SPF 9 times, router R2 executed SPF 5 times, router R3 executed SPF 9 times and the last router R4 executed SPF 2 times because all the routers are placed in only one common area that is area 0 or backbone area.

4.1.2 Scenario depicting areas as Area 0, Area 1 and Area 2

Overview of Scenario:
In this scenario we have mentioned area 0 as backbone area and area 1, area 2 as ordinary areas. There are four routers out of which routers R1 and R2 act as ABR – Area Border Routers, which connect two areas with each other that is Backbone Area and Normal or Ordinary Areas.

Scenario of Lab 2:

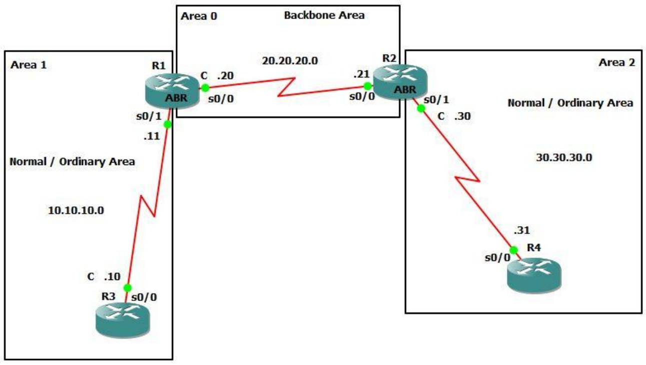

Figure 5: Scenario depicting areas as Area 0, Area 1 and Area 2

Outputs:
Router R1:
R1#show ip ospf
Area BACKBONE(0)
SPF algorithm executed 5 times
Area 1
SPF algorithm executed 3 times

Router R2:
R2#show ip ospf
Area BACKBONE(0)
SPF algorithm executed 3 times
Area 2

Router R3:
R3#show ip ospf
Area 1
SPF algorithm executed 5 times

Router R4:
R4#show ip ospf
Area 2
SPF algorithm executed 1 times

Explanation:
The result of the lab 2 shows that router R1 exists in two areas that is area 0 and area 1 so SPF calculated 2 times that is for area 0 SPF executed 5 times and for area 1 SPF executed 3 times. The router R2 also exists in 2 areas that is area 0 and area 1 so SPF calculated 2 times that is one for area 0 SPF executed for 3 times and for area 2 SPF executed for 4 times. The router R3 falls in area 1 so SPF executed 5 times and the last router R4 executed SPF only 1 time.

Comparison of Scenario 1 with Scenario 2:
As we compare both the scenarios, we found that when whole scenario is divided into various areas, then the SPF execution is also less as compared to only one area. So due to this the convergence time also decreases, with lesser queuing delay and thus congestion can also be controlled.

Table 1: Comparison of two different scenarios

Areas	No. of Routers	Scenario 1 with only Area 0(SPF Executed)	Scenario 2 with 3 Areas (SPF Executed)
0	R1	9	5
0	R2	5	3
0	R3	9	-
0	R4	2	-
1	R1	-	3
1	R2	-	-
1	R3	-	5
1	R4	-	-
2	R1	-	-
2	R2	-	4
2	R3	-	-
2	R4	-	1

4.1.3 Scenario depicting EIGRP with 4 Routers and 2 Hosts

Overview of Scenario:
There are four Routers used in this scenario by serial link and they are connected by EIGRP protocol. The objective of this lab is to study the EIGRP traffic.

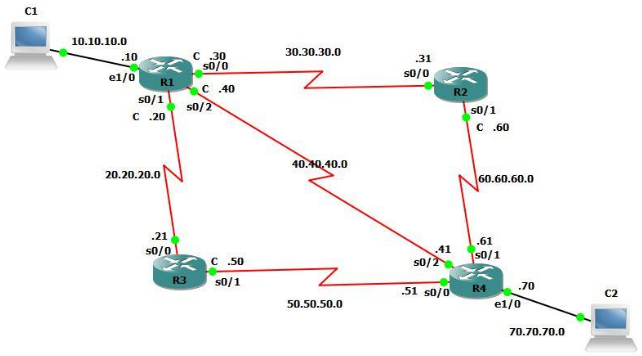

Figure 6: Scenario depicting EIGRP with 4 Routers and 2 Hosts

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Outputs:
Router R1:
R1#show ip eigrp traffic
IP-EIGRP Traffic Statistics for AS 10
Hellos sent/received: 438/286
Updates sent/received: 21/21
Queries sent/received: 0/2
Replies sent/received: 2/0
Acks sent/received: 17/14
Input queue high water mark 2, 0 drops
SIA-Queries sent/received: 0/0
SIA-Replies sent/received: 0/0
Hello Process ID: 184
PDM Process ID: 182

Explanation:
This scenario explains about the EIGRP Traffic Statistics such as Hellos sent/received, Updates sent/received, Queries sent/received, Replies sent/received, Acknowledgements sent/received, Input queue.

4.2 Simulation Framework for Routing Protocols
According to the proposed work, firstly the scenario is divided into different areas like area 0, area 1 and area 2 in case of routing protocol – OSPF. The scenario is as shown below:

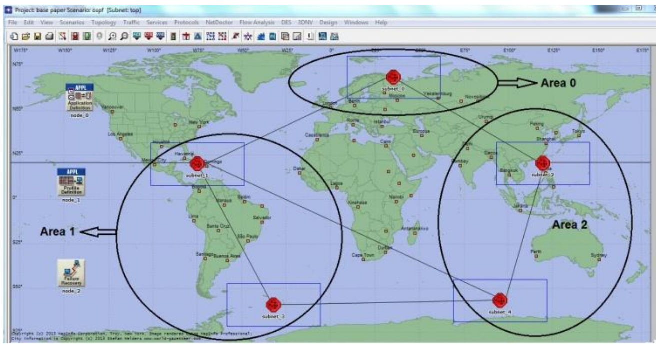

Figure 7: Network Topology (Parent Subnets)

Now the above scenario has 5 Subnets, all the subnets are connected to other subnets by PPP DS3 links and there are 3 other nodes as Application Definition node, Profile Definition node and Failure Recovery Node. The all five Subnets are divided into 3 areas as Subnet_0 in area0, 2 subnets as subnet_1 and subnet_3 are in area 1 and the other 2 Subnets as subnet_2 and subnet_4 are in area2. Each Subnet has its internal structure also that is defined as follows:

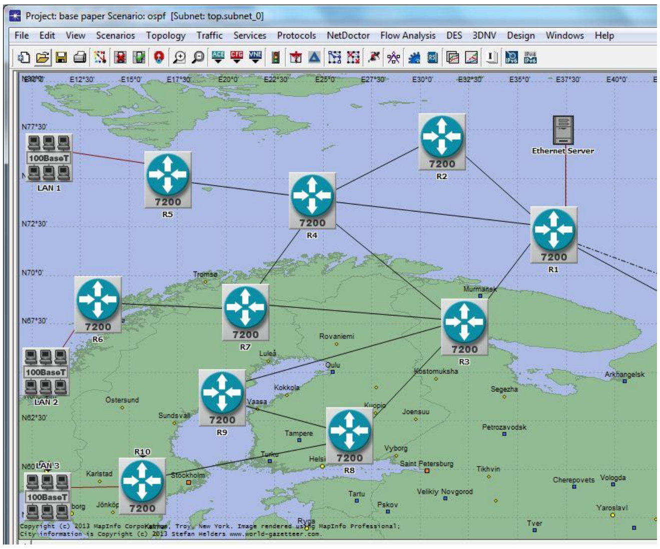

Figure 8: Internal Scenario of Each Subnet

PPP DS3 links are used to connect all routers with each other and Ethernet 100 Base T links are used to connect Ehternet Server with the Router and LAN1, LAN2, LAN3 with the Routers. Now we take under consideration the three parameters as Network convergence activity, Delay and Traffic Sent(bits/sec).

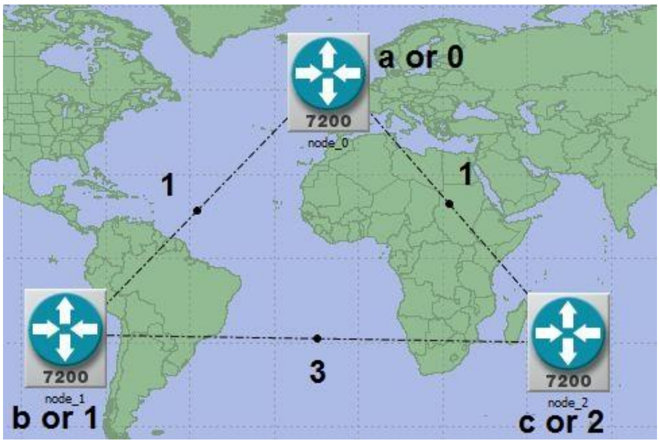

Figure 9: Small Network having 3 Nodes

5. Proposed Work in C++
Basically there are 4 parameters which are taken under consideration while designing a new routing algorithm in C++. The parameters are Congestion Control, Load Balancing, Delay and Network Utilization.
Congestion Control: The congestion can be controlled if we switch the data from one path to another path, if the first path gets congested upto its extreme level or peak level.
Load balancing: By the help of load balancing, the load can be switched among different paths in the network so that no path gets congested and throughput of the network does not suffers.

Delay: The delay can also be improved by our proposed work, such that data can follow many paths towards the destination instead of a single path. Hence time is reduces drastically.
Network Utilization: All the links in the network have to be used so that the efficiency of the network is increased.

5.1 Algorithm in Steps

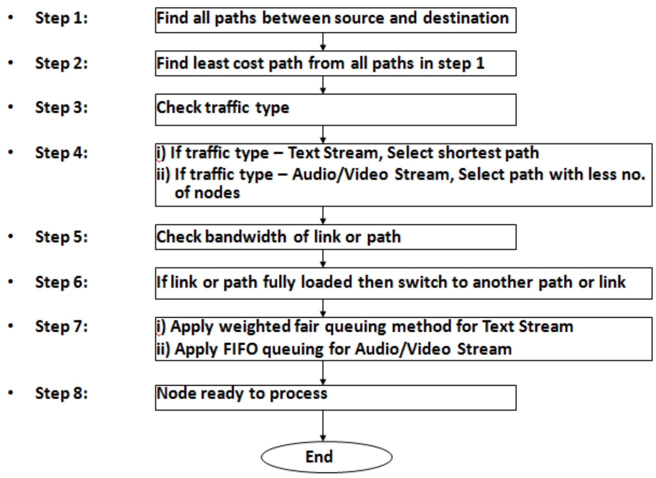

Figure 10: Flowchart of the proposed work.

5.2 Pseudo-code of Proposed Routing Algorithm

```
N has nodes like n0, n1, n2,…….nn and costs as c(n1,n2)
Where c(ni, nj) = infinity if (ni, nj) is not a link in the N
C matrix having n nodes with costs of N
New matrix S[i, j] having shortest path from node ni to nj
min is minimum value function
For i, j = 1, 2,……n
C[i, j]=0;
Then set S[i, j]:= infinity;
Else set S[i, j]:= C[i, j]
End for;
For i, j, k = 1, 2,........n
Set S[i, j]:= min(S[i, j], S[i, k] + S[k, j])
For end;
If (each path first node address == source node address)
Then discard that path;
Route:= next path;
End if;
If traffictype = text
If shortest path bandwidth < link bandwidth;
Continue;
Wfq=number of weighted fair queues at each node, x=1,2,...n
If wfqx !=0
Continue;
Else
Queue is empty;
Else
Choose another path;
Wfq=number of weighted fair queues at each node, x=1,2,...n
If wfqx !=0
Continue;
Else
Queue is empty;
Elseiftraffictype = audio or video stream
For each shortest path
Minimum=number of nodes in path i, i=1,2,…..m
If minimum>number of nodes in path I;
Continue;
Fifo=length of Fifo queue, p=1,2,...n
If p !=0
Continue;
Else
Queue is empty;
Else
Next path with minimum nodes;
Fifo=length of Fifo queue, p=1,2,...n
If p !=0
Continue;
Else
Queue is empty;
End for;
End if;
```

Explanation:
The pseudo-code of proposed routing algorithm consists of N as Network, n acts as number of nodes in the Network N, c represents the costs given to the links in the Network N. Matrix C is having n nodes with costs of various links in the Network N. There is one new matrix S, which contains the shortest path for each node from ni to nj. Min acts as a minimum value function. Now the new matrix is made by the help of equation S[i, j]:= min(S[i, j], S[i, k] + S[k, j]). The values i.e. costs in the new matrix are calculated again and again unless all the infinity costs can be replaced with the positive costs. This is because from each node to the other node there is some path unless that path is not direct that is there are so many nodes which come in that path. Now the minimum costs are found from each node to other node. Now loops can be detected and these can be avoided. Suppose source node sends the data to next node i.e. to its shortest path's first node. Now that node again checks which path is shortest for further transmitting of the data. If that node has its first shortest path to send the data but that path has source node as first node, so due to this, loop can be detected. To avoid the loop that path is discarded which has a first node as source node because if data is again sent to source node then on the other hand source node again checks its routing table for first shortest path and find the first node same from where data comes, so loops will occur. To avoid loops, discard the path which has first nodes as source nodes in their first shortest paths. After finalizing of the first shortest path, now traffic type is checked that whether traffic is simple text or audio/video stream. If the traffic type is simple text stream then check whether the first path is fully congested or not, if the path is fully congested to its peak level or extreme level by comparing with the given bandwidth of the link, then switch to other shortest path. For text traffic, weighted fair queue method is used for controlling the congestion and to improve the quality of service. By this way packets are prioritized at each node. Now if the traffic type is of audio/video stream, the shortest paths have already been found in the above section of pseudo-code, now compare all the respective shortest path's

number of nodes with each other. When the path with minimum number of nodes is found, then that path is selected for transmission of this type of traffic. Now FIFO queuing method is used to control the congestion and improve the quality of service at each node. Now selected node is ready to process the data.

6. Results using OPNET

The graph shown in Figure 11 is the network containing the overlaid statistics of the average Traffic sent (bits/second) in OSPF and EIGRP Scenario.

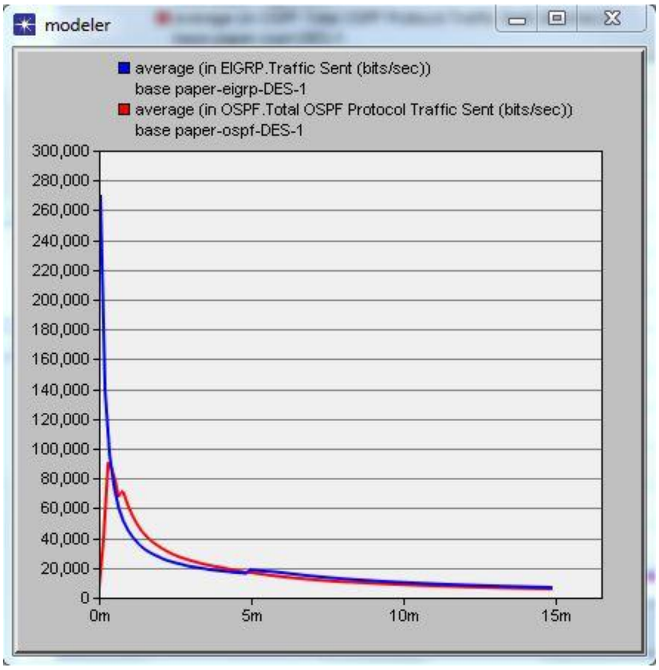

Figure 11: Traffic Sent (bits/sec)

Hence it can be concluded that EIGRP performs better in terms of routing the traffic (traffic sent(bits/sec)).
The graph shown in the following Figure 12 is the network containing the overlaid statistics on the average Delay in OSPF and EIGRP Scenario.

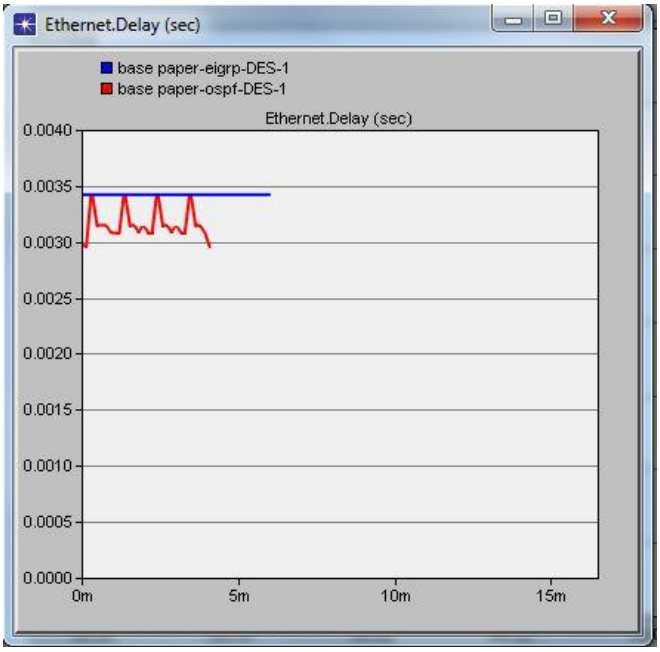

Figure 12: Delay in OSPF and EIGRP

Now it can be concluded that OSPF performs better in terms of Ethernet delay.
The graph shown below is the network containing the overlaid statistics of the average Network Convergence Activity in OSPF and EIGRP scenario.

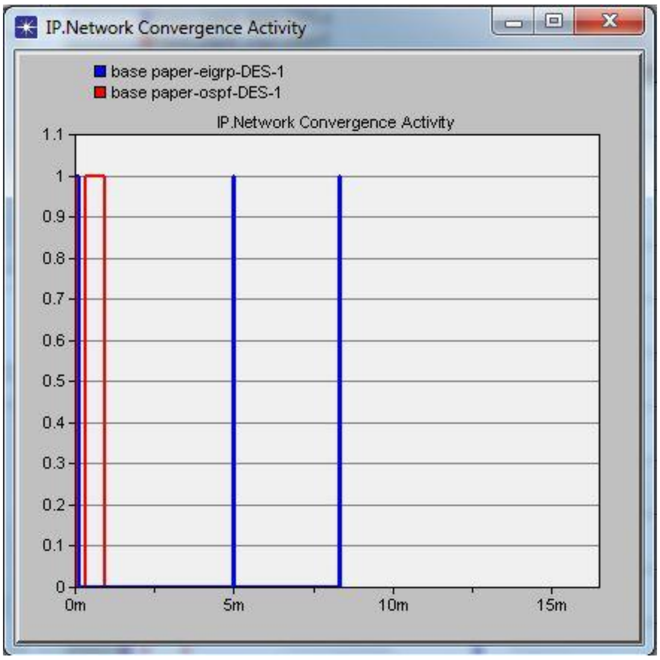

Figure 13: Network Convergence Activity during failure

From above graph, we can conclude that as compared to EIGRP, OSPF performs better in terms of network convergence.

Results of Proposed algorithm using C++:

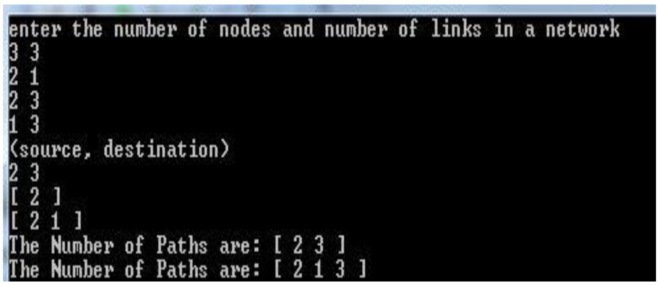

Figure 14: All Paths from S to D

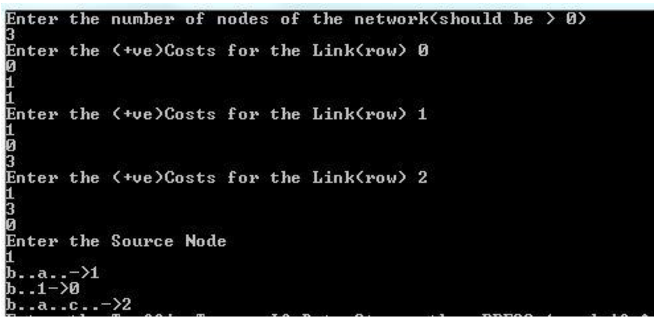

Figure 15: Result of Routing Algorithm for Finding Shortest Paths

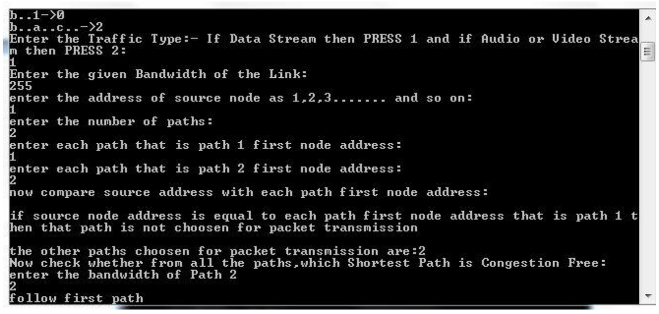

Figure 16: Result of Routing Algorithm for Finding Congestion Free Path

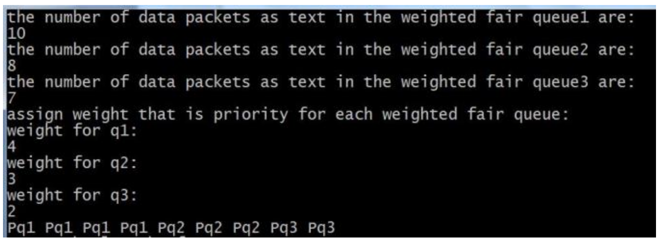

Figure 17: Weighted Fair Queuing where Pq represents packets in the queue

The following Image shows the number of Packets sent as P as entered by the user:

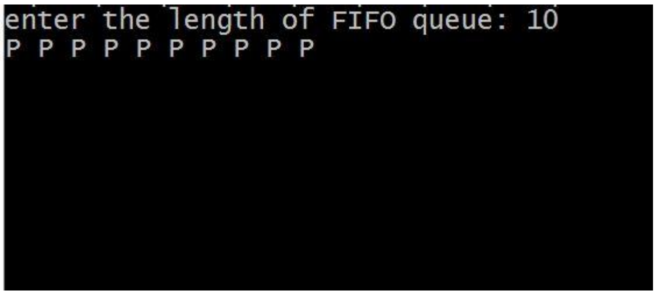

Figure 18: FIFO Queue

7. Conclusion

Conclusion can be drawn by considering OSPF in both the scenarios i.e. one having only backbone area and other having different areas like area 0, area 1 and area 2 and then comparing the outputs with the EIGRP. According to first scenario only area 0 is configured in OSPF then it lacks in traffic sent (bits/sec) and during network convergence parameters. OSPF with area 0 has only better performance with regard to Ethernet delay. So during traffic sent (bits/sec) and during network convergence parameters, EIGRP stands better. On the other hand, when we configure the OSPF with multiple areas, then we found that OSPF can get better output as compared to EIGRP in case of network convergence and Ethernet delay parameters.

The second major conclusion is that a new routing protocol in implemented which can control the congestion in the network, balance the load in the network, provide less delay and hence better network utilization can be achieved. This routing protocol gives the node a choice of next hops for the same destination. The proposed algorithm gives solutions for effectively calculating the multiple paths and ways to minimize delay and increase the throughput. The algorithm is capable of aggregating the resources of many paths and reducing the blocking capabilities in QoS oriented networks allowing data transfer at higher rate when compared to only one path. It also increases the reliability of delivery. So, Many paths can be effectively used for maximum utilization of network resources. As compared to a single path there are many paths which can take participation during the transmission of data with regard to some constraints for resilient routing mechanism.

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